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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : F42B 12/24

A1

(11) International Publication Number: WO 97/16696

(43) International Publication Date: 9 May 1997 (09.05.97)

(21) International Application Number: PCT/EP96/04521

(22) International Filing Date: 17 October 1996 (17.10.96)

(30) Priority Data:
1001556 2 November 1995 (02.11.95) NL

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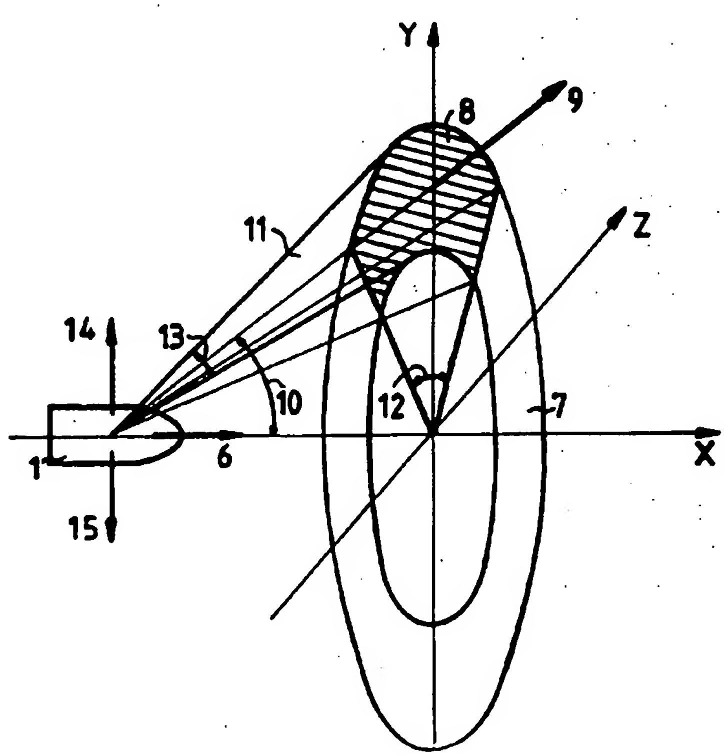
(81) Designated States: AU, BR, CA, CN, CZ, HU, IL, JP, KP, KR, MX, NO, NZ, PL, RU, SG, TR, UA, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.

(54) Title: FRAGMENTABLE PROJECTILE, WEAPON SYSTEM AND METHOD FOR DESTROYING A TARGET

(57) Abstract

The invention relates to a fragmentable projectile (1). The projectile (1) fragments in a main direction that forms an angle (10) with the projectile's direction of motion (6) and at least substantially in a volume of space (11) of which a main direction (9) does not coincide with the projectile's (1) direction of motion (6). In flight, the projectile (1) rotates about its axis. The projectile (1) fragments at a moment that it is in sufficiently close proximity to the target (21) and has assumed the correct rotational position for its fragments to hit the target (21).



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FRAGMENTABLE PROJECTILE, WEAPON SYSTEM AND METHOD FOR DESTROYING A TARGET.

The invention relates to a projectile for destroying a target, provided with fragmentation means, detonation means and ignition means for detonating the detonation means.

The invention also relates to a weapon system for destroying a target, comprising a fire control system for tracking the target, a launching tube for launching projectiles provided with fragmentation means and detonation means and ignition means for igniting the detonation means.

The invention furthermore relates to a method for destroying a target using projectiles, provided with fragmentation means and detonation means and ignition means for igniting the detonation means comprising the steps of: detecting the target by means of a target sensor; directing a launching tube on the basis of information supplied by the target sensor; and launching one or more projectiles by means of the launching tube.

When employing projectiles against flying targets, the possibility of hitting a target is more or less remote. In view of this, use is often made of fragmentation projectiles that disintegrate into fragments when the target is at sufficiently close range. These projectile fragments are thus assumed to hit the target. The projectile can autonomously determine the moment of fragmentation, by for instance the incorporation of a proximity fuze. This will usually cause the projectile to fragment at the moment it passes the target. In order to realize a favourable hit probability, use is made of a wide fragment beam.

Owing to the space required, proximity fuzes are mostly used for shells with calibers of 40 mm and greater. A typical final velocity of the projectile will be in the order of 500 m/s and a typical velocity at which the fragment spray is hurled outwards will be in the order of 1700 m/s. The drawback of conventional projectile types with proximity fuzes is that the distance at which the fragment density is still sufficiently high for destroying the target is relatively short.

Another type of projectile that obviates this drawback is known by the name of AHEAD munition. In this case the projectile fragments in the shape of a narrow conical envelope of which the main direction coincides with the projectile's direction of motion. Also at greater distances, this will ensure a fragment density that is sufficiently high for destroying the target. Instead of a proximity fuze which is generally not set off until the fly-by moment, a "time imprinting" mechanism is generally used for the fragmentation of this type of munition. The initial velocity of the projectile at the time of launching is measured on the basis of which the projectile is imprinted with the time of fragmentation. The drawback of such a projectile is that in order to hit the target, the trajectory described by the fragments is required to practically coincide with the target trajectory. In actuality this means that this type of projectile has to approach the target up to a range of 2 or 3 metres. As a result of various recurrent error factors, such as target manoeuvres and inaccuracies in trajectory model, this is difficult to realize in practice.

A solution to this problem can be found in providing the projectile with facilities for in-flight corrections. This however entails considerable expenses and adds to the projectile's weight.

Another solution is known from the U.S. patent specification US-A 5,322,016. This patent specification describes a projectile that fragments in such a way that the fragments are hurled outwards in an expanding ring on the assumption that at least some fragments will hit the target. The projectile in said patent specification is detonated by means of telemetry. Viewed spatially, the projectile's forward speed causes the fragments to move between an inner conical envelope and an outer conical envelope with a common main direction that coincides with the projectile's direction of motion. Thus, a far denser fragment beam is accomplished, hence in principle a lower hit probability with the same volume of fragments than if conventional projectiles with proximity fuzes are used. By carefully monitoring the target position and the projectile position and by making use of a telemetry signal for detonation, an ignition time can be determined such that the probability of the target being hit by the fragments concentrated in the ring is increased. The drawback of such a projectile is that the fragment density at the point of impact is still relatively low.

The projectile, the weapon system and the method according to the invention aims at realizing a concentrated fragment beam and, simultaneously, a reasonable hit probability, also in the event of a considerable miss distance (the distance by which the projectile passes the target), without the need to provide the projectile with expensive facilities.

The projectile according to the invention is thereto characterized in that it is designed to fragment at least substantially in a volume of space of which a main direction does not coincide with the projectile's direction of motion.

The weapon system according to the invention is thereto characterized in that the projectiles are, per projectile, designed to fragment at least substantially in a volume of space of which a main direction does not coincide with the projectile's direction of motion.

The method according to the invention is thereto characterized in that a projectile, when in sufficiently close proximity to the target, fragments substantially in a direction of the target and in a volume of space of which a main direction does not coincide with the projectile's direction of motion.

The projectile according to the invention may also comprise a missile. The fragmentation means may comprise all kinds of fragments. In case of the projectile, weapon system and method according to the invention, this causes a narrower fragment beam as a result of which, with far smaller caliber munition, the same kill probability can be achieved as with conventional munition. In the event of a greater miss distance, corrections are possible by causing detonation to take place on the moment that the projectile has assumed such a rotational position that the target can be hit by the fragments, which will result in a considerable increase of the average kill probability per shot.

It should be noted that at projectile fragmentation, the mass centre of the totality of scattered fragments continues to follow the projectile trajectory on the basis

of the law of conservation of momentum, except in case of extraneous forces, such as air resistance. Consequently, if a concentrated fragment beam is to be realized substantially in a certain direction, a sufficiently great countermass has to be moved in the opposite direction. In this respect, the projectile body, but also an additional fragment beam could be considered.

In determining the spatial distribution of fragments, the hit probability and the density of the fragment beam shall be balanced against each other. With a high density of the fragment beam, the target, if hit, will in all probability be destroyed. The probability of the target being hit increases however as the distribution of the fragment beam increases which, however, causes the fragment density to be reduced. A favourable compromise is reached in an embodiment of the projectile, characterized in that an intersection of the volume of space by a plane perpendicular to the projectile's direction of motion encloses an angle of 5 to 90 degrees.

On the same grounds, an advantageous comprise is reached in an embodiment of the projectile, characterized in that an intersection of the volume of space by a plane through the direction of motion and the main direction of the volume of space encloses an angle of 5 to 30 degrees.

An advantageous way to accomplish a concentrated fragment beam is found in an embodiment of the projectile, characterized in that the fragmentation means are contained in a barrel-shaped cavity in the projectile, which encloses an angle unequal to zero with the projectile's direction of motion. At its exit side, the barrel-shaped cavity is preferably covered by a relatively weak side wall so that

when fragmentation occurs, the fragments will emerge from the relatively weak side wall.

There are various ways to cause a projectile to fragment. In a first advantageous embodiment this is effected on the basis of information transmitted by means of telemetry. The fragmentation signal may be directly transmitted by telemetry, another possibility is that the projectile autonomously determines the most opportune fragmentation moment on the basis of information transmitted by telemetry. This moment does not occur until the projectile has assumed a suitable roll position, so that the main direction of the fragment beam is toward the target.

To this end, an advantageous embodiment of the projectile according to the invention is characterized in that the projectile is further provided with reception means for receiving external information and that the ignition means are designed to activate on the basis of the received external information.

On the basis of this, a further advantageous embodiment of the projectile according to the invention is characterized in that the ignition means are also designed to activate on the basis of information pertaining to the projectile's roll position. The projectile can determine its roll position on the basis of the external information in which process an external sensor measures the projectile's roll position and transfers the resulting information to the projectile by means of telemetry. It is also possible for the projectile to measure its own roll position, for instance by means of a gyroscope, or in a manner set forth in the European patent specifications EP-B 0.239.156, EP-B 0.341.772 or EP-B 0.345.836 where the roll position is calculated by determining the direction of electromagnetic

flux lines related to radio waves emitted by a ground station.

A further advantageous embodiment of the projectile according to the invention is thereto characterized in that the projectile is provided with means for determining its own roll position.

Another advantageous embodiment of the projectile according to the invention is characterized in that the means for determining the roll position are designed to determine the projectile's roll position on the basis of the received external information.

The external information may be derived from a fire control system which, by means of a target sensor, continuously determines the target position. By means of this or another sensor or on the basis of a ballistic model, possibly combined with a measurement of the projectile's initial velocity, the projectile position can be continuously determined. This enables the fire control system to continuously determine the position of the projectile relative to the target. If the projectile is sufficiently close to the target, the fire control system can generate a trigger signal. On the basis of this signal, the projectile produces an enable signal to activate the detonation means. However, the chances are that the projectile has not yet assumed the correct roll position so that fragmentation will not take place in the direction of the target. This can be solved by delaying the fragmentation until the projectile has assumed the correct roll position. The fire control system can practically continuously determine and transmit this correct roll angle, or offset roll angle, on the basis of the relative position of the target with respect to the projectile. It is also conceivable that the

relative position of the target with respect to the projectile, or the absolute position of the target and the absolute position of the projectile, is practically continuously transmitted. On the basis of the information transmitted the projectile can determine an offset roll angle, and continuously compare this with its actual roll angle. When these angles are at least substantially identical, the projectile can be made to fragment providing that the enable signal has been released.

A further advantageous embodiment of the projectile according to the invention is therefore characterized in that the projectile is provided with means for applying an enable signal to the ignition mechanism to enable ignition, and with means for extracting a desired offset roll angle from the external information, and with means for activating the ignition means on the moment that the enable signal is released and that the roll position of the projectile at least substantially coincides with the desired offset roll angle.

Instead of by means of telemetry, the enable signal can also be produced on the basis of information from a proximity fuze, which has the advantage of being far less susceptible to jamming.

A further advantageous embodiment of the projectile according to the invention is therefore characterized in that it is provided with a proximity fuze, the enable signal being released on the basis of information from the proximity fuze.

In actual practice, several projectiles will be fired at the target to increase the kill probability. However, for each projectile a different moment obtains on which the

enable signal is to be released as well as a different offset roll angle at which fragmentation may take place. This problem can be solved by encoding the transmitted signals per projectile, so that each projectile can select its own relevant information. The European patent specification EP-B 0.354.608 discloses an encoding procedure for each projectile fired. A series of projectiles fired in rapid succession may select information with an identical code causing them to activate at the same roll position after release of the enable signal. This will result in a sort of "barrage" in a certain direction which will increase the probability of destruction. It will usually be sufficient to substantially continuously transmit a single offset roll angle. The projectile which is sufficiently close to the target can use this offset roll angle to detonate. This then yields a saving in bandwidth of the signals to be transmitted.

A further advantageous embodiment of the projectile according to the invention is therefore characterized in that the projectile is furthermore provided with a decoding device for selecting information concerning the projectile from the external information, provided that this information is coded.

In an embodiment of the weapon system according to the invention, optimum use is made of the substantially laterally fragmentable projectiles by causing them to fragment remotely on the basis of information from the fire control system. In this case, the projectile itself determines the most opportune fragmentation moment on the basis of information transmitted by the fire control system.

A further advantageous embodiment of the weapon system according to the invention is characterized in that the projectiles are provided with reception means for receiving external information, and that the ignition means are designed to activate on the basis of the external information, and that the fire control system is designed to transmit the external information.

In an embodiment of the weapon system according to the invention, means are preferably provided for imparting a rotating movement to the projectiles so that these acquire a controlled rotation. These means may be attached to the projectile itself, by for instance specifically shaped fins, although the rotation can also be produced by the combined action of launching tube and projectile. Owing to its rotation and forward speed, the projectile will describe a spiral trajectory. After a complete rotation, the projectile has covered a certain distance, which distance, i.e. the "pitch" of the spiral trajectory is shorter as the speed of rotation in proportion to the forward speed is higher. This will yield several moments, at least if the projectile is in the vicinity of the target, for the projectile fragments to hit the target. This number of moments will increase as the projectile's speed of rotation in proportion to its forward speed is higher. This enables the target trajectory to be continuously covered by a concentrated fragment beam, which is a considerable advantage compared to conventional fragmentable projectiles. The projectile can be provided with means to determine its roll position and can, on the basis of roll angle measurements and information pertaining to its own position relative to the target, be made to fragment at a suitable roll angle.

A further advantageous embodiment of the weapon system according to the invention is therefore characterized in that means are provided for imparting a rotating movement to the projectiles, and that the projectiles are, per projectile, provided with means for determining the roll position, and that the ignition means are also designed to activate on the basis of the roll angle information combined with the external information.

On the basis of measured target positions and projectile positions, the fire control system can determine a suitable offset roll angle that a projectile is to assume for its fragments to hit the target.

A further advantageous embodiment of the weapon system according to the invention is therefore characterized in that the external information comprises information pertaining to the offset roll angle on the basis of which a certain projectile fired can determine an offset roll angle that the certain projectile fired is to assume at the moment of fragmentation for its fragments to achieve a reasonable hit probability, if the projectile would be sufficiently close to the target. Subsequently, the fire control system itself can transmit the offset roll angle. Alternatively, the target position and the projectile position, or the target position relative to the projectile position can be transmitted, so that the projectile itself can determine the offset roll angle.

A further advantageous embodiment of the weapon system according to the invention is therefore characterized in that the information pertaining to the offset roll angle comprises the actual offset roll angle, which has been determined on the basis of the target position and the position of the certain projectile fired.

A further advantageous embodiment of the weapon system according to the invention is therefore characterized in that the information pertaining to the offset roll angle comprises the target position and the position of the certain projectile fired.

Another advantageous embodiment of the weapon system according to the invention is therefore characterized in that the information pertaining to the offset roll angle comprises the relative position of the target with respect to the certain projectile fired, which has been determined on the basis of the target position and the position of the certain projectile fired.

The offset roll angle can be determined on the basis of projectile position measurements. However, a less expensive, albeit less accurate procedure would be to obviate the need for measuring these positions by determining the offset roll angle by means of an accurate ballistic model.

A further advantageous embodiment of the weapon system according to the invention is characterized in that the position of the certain projectile fired comprises a position determined on the basis of both a ballistic model and a measured initial velocity of the certain projectile fired.

It will now be possible for the fire control system to generate an enable signal if the projectile is within sufficiently close range to the target; fragmentation does not occur until the projectile has assumed a suitable roll position.

A further advantageous embodiment of the weapon system according to the invention is characterized in that the external information also comprises an enable signal for the ignition of the detonation means in a projectile that has come within sufficiently close range to the target.

Fragmentation will preferably take place such that the main direction of the fragment sector is towards the target so as to ensure a maximum hit probability.

A further advantageous embodiment of the weapon system according to the invention is characterized in that the desired offset roll angle is selected such that the main direction of the sensor is substantially towards the target.

To enable the weapon system to fire several projectiles in rapid succession, it is recommendable to provide each projectile with a code to allow each projectile to select its own relevant information. Subsequently, the fire control system can calculate offset roll angles for each projectile or for a sequence of projectiles flying close together and transmit these as a code.

A further advantageous embodiment of the weapon system according to the invention is thereto characterized in that the external information comprises coded information pertaining to the offset roll angle from which a series of offset roll angles can be determined, which information is valid, per offset roll angle, for one projectile or for a sequence of projectiles flying close together, the projectiles being provided with a decoding device with the aid of which a projectile can select an offset roll angle related to the projectile concerned from the series of offset roll angles.

In an advantageous embodiment of the method according to the invention, the projectile fragments in such a way that the probability of the target being hit by the fragments is sufficiently high.

A further advantageous embodiment of the method according to the invention is thereto characterized in that a rotating movement is imparted to the projectile, and that the projectile substantially continuously determines its rotational position, and that the projectile is at least substantially continuously provided with information pertaining to the offset roll angle on the basis of which the projectile determines the offset roll angle that it is to assume at the moment of fragmentation for its fragments to achieve a reasonable hit probability if the projectile would be sufficiently close to the target.

The projectile position can be continuously measured or may be determined by a ballistic model. The latter option entails less costs, although it is less accurate.

A further advantageous embodiment of the method according to the invention is thereto characterized in that the information pertaining to the offset roll angle is determined on the basis of a ballistic model of the projectile and on the basis of measured target positions.

Another advantageous embodiment of the method according to the invention is thereto characterized in that a ballistic model of the projectile, measured target positions, and a proximity criterion constitute the basis for determining whether the projectile is in sufficiently close proximity to the target.

A further advantageous embodiment of the method according to the invention is characterized in that on the basis of information from a proximity fuze and a proximity criterion, it is determined whether the projectile has come within sufficiently close range to the target.

A further advantageous embodiment of the method according to the invention is characterized in that the external information comprises coded information pertaining to the offset roll angle from which a series of offset roll angles can be determined, which information is, per offset roll angle, valid for one projectile or for a sequence of projectiles flying close together, the information pertaining to the offset roll angle being decoded, per projectile, to obtain an offset roll angle related to the projectile concerned.

The projectile, the weapon system and the method according to the invention will now described in greater detail with reference to the following figures, of which:

Fig. 1 represents an embodiment of the projectile according to the invention;

Fig. 2 shows how the projectile according to the invention can fragment;

Fig. 3 represents the coverage of a rotating projectile according to the invention;

Fig. 4 shows how the projectile according to the invention is to be employed;

Fig. 5 represents a weapon system according to the invention.

Fig. 1A and 1B represent an embodiment of the projectile according to the invention in respectively longitudinal section and cross section. The projectile preferably has a caliber ranging from 35 up to and including 76 mm, although other calibers are also possible. The projectile 1 is provided with a cavity 2 incorporating detonation means and fragmentation means. The cavity 2 is barrel-shaped, so that detonation will cause the fragments to be hurled outwards in an inclined forward direction. The projectile is on one side provided with a window 3 composed of a relatively weak material. During detonation, the projectile will fragment substantially in the direction of the window. The projectile may be provided with means for determining its rotational position with respect to its direction of motion. To this end, use is preferably made of the principle set forth in the European patent specifications EP-B 0.239.156, EP-B 0.341.772 or EP-B 0.345.836, where the roll position is determined by detection of this position relative to electromagnetic lines of flux emitted by a ground-based station. To this end, a receiver is to be incorporated to detect the direction of electromagnetic lines of flux. The projectile may additionally comprise a receiver to detect an external trigger signal for triggering the detonation means. If the electromagnetic field for determining the roll position is also used for transmitting the trigger signal, these two receivers may be combined which obviates the need for an additional receiver. Finally, a receiver for receiving an offset roll angle signal may be provided, which can also be combined with the said receivers. This offset roll angle signal can represent the offset roll angle that the projectile is to assume prior to detonation. The offset roll angle signal can then continuously be compared with the measured roll position. When the trigger signal has been released and the

offset roll angle corresponds with the measured roll position, the projectile may detonate.

Fig. 1C and 1D represent another embodiment of the projectile according to the invention in respectively longitudinal section and cross section. The cavity incorporating the fragmentable substance and the detonation means comprises an elongated duct 4. Throughout its entire length, the duct is covered by a window 5 of a relatively weak material type. In this embodiment, the angle formed by the main direction of the fragment beam and the projectile's direction of motion will at detonation be wider than in the embodiment shown in Fig. 1A and 1B. The distribution of the fragments will accordingly also be greater. This embodiment is suitable if a proximity fuze is used to detect the passage of the target. In that case, the target will more or less be opposite to the projectile's flank as a result of which a wider fragment beam is required to hit the target.

Fig. 2 represents a fragmentable projectile 1 according to the invention. The figure shows a system of coordinates represented by X, Y and Z. The projectile skims through space at a certain forward speed 6 instantaneously along the X-axis. A conventional type of projectile fragments in such a way that the fragments move apart in an expanding ring 7 with respect to the projectile position. The forward speed of the projectile will cause the fragments concentrated in the expanding ring to move between an inner conical envelope and an outer conical envelope with a common main direction that coincides with the projectile's direction of motion. The difference in apex between the inner cone and the outer cone determines the distribution of the fragments. In the projectile according to the invention, the projectile 1 fragments such that the

fragments move apart in a sector 8 of the expanding ring. A main direction in which the fragments move is indicated by arrow 9. The main direction forms an angle 10 with the projectile's direction of motion. Amongst other things, this depends on the forward speed of the projectile and the detonation force. As a consequence, the fragments move in a volume of space 11 which covers a subsector of the said inner cone and outer cone. The fragments which would normally move in the ring surrounding the projectile, are thus concentrated in a far smaller area as a result of which a considerably higher fragment density is achieved or, in case of corresponding density as a conventional projectile, a far greater misdistance can be bridged. The fragment density is also determined by the angle 12 formed by the intersection of the YZ plane perpendicular to the projectile's direction of motion and the fragment beam and by the angle 13 formed by the intersection of the XY plane, through the projectile's direction of motion 6 and the main direction 9 of the fragment beam, and the fragment beam. In Fig. 2, the angle 12 is approximately 90 degrees and the angle 13 is approximately 15 degrees, although other angles are also feasible. The selection of narrow angles results in a high density which, however, reduces the probability of the target being hit by the projectile fragments. The selection of wide angles yields a lower density and increases the hit probability. For the directions perpendicular to the projectile the optimum angle is between 5 and 90 degrees; for the directions parallel to the projectile the optimum angle is between 5 and 30 degrees. Relative to the projectile position at detonation, the fragments move in direction 14 which, as can be seen in Fig. 2, forms an angle of 90 degrees with the direction of motion. Other angles are also feasible in the embodiment of the projectile with the fragmentation means contained in a barrel-shaped cavity by selecting a different angle of the

barrel-shaped cavity. On the basis of the law of conservation of momentum, the projectile shell will move in the opposite direction 15 at a speed that depends on the mass relation between shell and fragmentation means and also on the detonation force. The shell is preferably designed to be heavier than the fragmentation means, depending on the necessary penetrating power of the fragments at a certain distance. If a proximity fuze is used, the angle formed by the main direction and the projectile's direction of motion will have to be wider than in case of detonation by external command, since in case of detonation by external command the projectile can be made to fragment earlier.

Fig. 3 represents the coverage of the fragments during the flight of a rotating projectile according to the invention, the fragment beam being a fictitious beam that would be caused if the projectile were to detonate. The projectile is represented in a first situation A where the main direction of the fragment beam 9 is in the plane of the drawing, and in a second situation B where the projectile has made a 360 degrees rotation. The main direction 9 of the fragment beam thus moves along a helical line along the projectile's axis of rotation 16. The underside 17 of the fragment beam in situation A and the top 18 of the fragment beam in situation B include a dead area 19 where a target cannot be hit. This dead area is smaller as the projectile's speed of rotation in proportion to its forward speed is higher. Fig. 3 furthermore shows an overlap area 20 where both in situation A and in situation B a target can be hit by the projectile.

Fig. 4A and 4B schematically shows, respectively in side view and front view with respect to projectile 1, how the projectile 1 according to the invention is to be deployed

against a target 21 that moves along target path 22. The projectile follows projectile trajectory 23. Two situations I and II have been shown as a function of time. In situation I the projectile is sufficiently close to the target for ensuring a hit at fragmentation if the projectile would have assumed the correct rotational position. This is however not the case, as is represented in Fig. 4B in front view. If the projectile were to detonate in situation I, the main direction 9 of the fragment beam would at that moment not coincide with the direction to the target 21. Fragmentation shall therefore be delayed until the projectile has rotated to such an extent that both directions coincide, as indicated in Fig. 4A and 4B by situation II. Although target and projectile will then be slightly displaced with respect to one another, the fragment beam is sufficiently wide to still realize a hit.

In order to determine whether the projectile is in sufficiently close proximity to the target, the projectile is provided with a receiver and the fire control system will transmit a signal to the projectile in situation I. This signal is a necessary enable signal for detonation, although in itself it is not sufficient to cause detonation. Furthermore, the fire control system transmits substantially continuously the direction of the projectile 1 to the target 21. The projectile continuously measures its rotational position in space and compares the actual rotational position with the target direction. In situation II these correspond after which detonation will occur. In case of detonation by means of telemetry, the fact that the projectile has not yet assumed the correct rotational position may be taken into account when releasing the enable signal. In the worst case situation the rotational position is 180 degrees in the wrong direction. The enable

signal is thus preferably advanced by the time required for the projectile to perform a 180 degrees rotation. Thus, the ignition time will not deviate more than this time with respect to the ideal ignition time. Owing to the width of the fragment beam, there is always a certain tolerance.

Fig. 5 represents a weapon system according to the invention. A target tracking system 24 tracks the target 25, an aircraft for instance, and sends the target data to a gun system 26 which, if missiles are concerned, may also comprise a missile launching tube. A fire control system calculates a suitable lead angle in a manner known in the art after which the projectiles 1 are fired. The fire control system determines the projectile position by means of a trajectory model. The target position is also continuously determined. Thus, the relative position of the projectiles with respect to the target 25 is always known and, consequently, also the offset roll angle that each projectile is to assume at the moment of fragmentation for its fragments to achieve a reasonable hit probability if the projectile concerned would be sufficiently close to the target. A transmitting antenna 27 continuously transmits these relative positions or offset roll angles, which, in case of a plurality of projectiles, can be encoded to enable the projectile to select its own relevant offset roll angle. The offset roll angles may also be transmitted at different frequencies. The offset roll angles can be transmitted continuously, or at least at a moment that a projectile is in sufficiently close proximity to the target. Another possibility is, assuming that a projectile is within the correct range to the target, to continuously transmit the roll angle related to this (fictitious) projectile. In this case, only one roll angle has to be transmitted, which is advantageous to reduce the bandwidth of the signals to be transmitted. The transmitting antenna

27 can also transmit an electromagnetic field on the basis of which the projectiles can determine their roll position, as for instance described in EP-B 0.239.156, EP-B 0.341.772 or EP-B 0.345.836, where the roll position is calculated by determining the direction of emitted electromagnetic flux lines. Finally, the transmitting antenna can if necessary also transmit coded trigger signals, if a projectile has come within sufficiently close range to the target. Naturally, for these three actions, separate transmitting antennas may be used, possibly disposed at different locations.

Claims:

1. Projectile for destroying a target, provided with fragmentation means, detonation means and ignition means for detonating the detonation means, characterized in that the projectile is designed to fragment at least substantially in a volume of space of which a main direction does not coincide with the projectile's direction of motion.

2. Projectile as claimed in claim 1, characterized in that an intersection of the volume of space by a plane perpendicular to the projectile's direction of motion encloses an angle of 5 to 90 degrees.

3. Projectile as claimed in claim 1 or 2, characterized in that an intersection of the volume of space by a plane through the direction of motion and the main direction of the fragment beam substantially encloses an angle of 5 to 30 degrees.

4. Projectile as claimed in any of the preceding claims, characterized in that the fragmentation means are contained in a barrel-shaped cavity in the projectile, which encloses an angle unequal to zero with the projectile's direction of motion.

5. Projectile as claimed in claim 4, characterized in that at its exit side, the barrel-shaped cavity is preferably covered by a relatively weak side wall.

6. Projectile as claimed in claim 4 or 5, characterized in that the side wall is lengthwise provided with a strip composed of a relatively weak material.

7. Projectile as claimed in any of the preceding claims, characterized in that the projectile is provided with reception means for receiving external information and that the ignition means are designed to activate on the basis of the received external information.

8. Projectile as claimed in claim 7, characterized in that the ignition means are also designed to activate on the basis of information pertaining to the projectile's roll position.

9. Projectile as claimed in claim 8, characterized in that the projectile is provided with means for determining its own roll position.

10. Projectile as claimed in claim 9, characterized in that the means for determining the roll position are designed to determine the projectile's roll position on the basis of the received external information.

11. Projectile as claimed in any of the claims 8 through 10, characterized in that the projectile is provided with means for applying an enable signal to the ignition mechanism to enable ignition, and with means for extracting a desired roll angle from the external information, and with means for activating the ignition means on the moment that the enable signal is released and that the roll position of the projectile at least substantially coincides with the desired offset roll angle.

12. Projectile as claimed in claim 11, characterized in that it is provided with a proximity fuze and that the enable signal is released on the basis of information from the proximity fuze.

13. Projectile as claimed in claim 11, characterized in that the enable signal is released on the basis of the external information.

14. Projectile as claimed in any of the claims 7 through 13, characterized in that the projectile is furthermore provided with a decoding device for selecting information concerning the projectile from the external information, provided that this information is coded.

15. Weapon system for destroying a target, comprising a fire control system for tracking the target, a launching tube for launching projectiles provided with fragmentation means, detonation means and ignition means for igniting the detonation means, characterized in that the projectiles are designed to fragment at least substantially in a volume of space of which a main direction does not coincide with the projectile's direction of motion.

16. Weapon system as claimed in claim 15, characterized in that the projectiles are, per projectile, provided with means for receiving external information, and that the ignition means are designed to activate on the basis of the external information, and that the fire control system is designed to transmit the external information.

17. Weapon system as claimed in claim 16, characterized in that there are furthermore provided means for imparting a rotating movement to the projectiles, and that the projectiles are, per projectile, provided with means for determining the roll position, and that the ignition means are also designed to activate on the basis of the roll position information in combination with the external information.

18. Weapon system as claimed in claim 17, characterized in that the external information comprises information pertaining to the offset roll angle on the basis of which it is possible for a certain projectile fired to determine an offset roll angle that a certain projectile fired is to assume at the moment of fragmentation for its fragments to achieve a reasonable hit probability, if the projectile would be sufficiently close to the target.

19. Weapon system as claimed in claim 18, characterized in that the information pertaining to the offset roll angle comprises the actual offset roll angle, which has been determined on the basis of the target position and the position of the certain projectile fired.

20. Weapon system as claimed in claim 18, characterized in that the information pertaining to the offset roll angle comprises the target position and the position of the certain projectile fired.

21. Weapon system as claimed in claim 18, characterized in that the information pertaining to the offset roll angle comprises the relative position of the target with respect to the certain projectile fired and which has been determined on the basis of the target position and the position of the certain projectile fired.

22. Weapon system as claimed in claim 19, 20 or 21, characterized in that the position of the certain projectile fired comprises a position determined from a ballistic model and a measured initial velocity of the certain projectile fired.

23. Weapon system as claimed in claim 19, 20 or 21, characterized in that the position of the certain

projectile fired comprises a measured position of the certain projectile fired.

24. Weapon system as claimed in any of the claims 16 through 23, characterized in that the external information also comprises an enable signal to cause ignition of the fragmentation means in a projectile that has come within sufficiently close range to the target.

25. Weapon system as claimed in any of the claims 16 through 24, characterized in that the desired offset roll angle is selected such that the main direction of the volume of space is substantially towards the target.

26. Weapon system as claimed in any of the claims 18 through 25, characterized in that the external information comprises coded information pertaining to the offset roll angle from which a series of offset roll angles can be determined, which information is valid, per offset roll angle, for one projectile or for a sequence of projectiles flying close together, the projectiles being provided with a decoding device with the aid of which a projectile can select an offset roll angle related to the projectile concerned from the series of offset roll angles.

27. Method for destroying a target using projectiles, provided with fragmentation means, detonation means and ignition means for igniting the detonation means, comprising the steps of: detecting the target by means of a target sensor; controlling a launching tube on the basis of information supplied by the target sensor; and launching one or a plurality of projectiles by means of the launching tube, characterized in that the projectile, when in sufficiently close proximity to the target, fragments substantially in a direction toward the target and in a

volume of space of which a main direction does not coincide with the projectile's direction of motion.

28. Method as claimed in claim 27, characterized in that an intersection of the volume of space by a plane perpendicular to the projectile's direction of motion encloses an angle of 5 to 30 degrees.

29. Method as claimed in claim 27 or 28, characterized in that an intersection of the volume of space by a plane through the direction of motion and the main direction of the volume of space encloses an angle of 5 to 30 degrees.

30. Method as claimed in any of the claims 27 through 29, characterized in that a rotating movement is imparted to the projectile, and that the projectile substantially continuously determines its rotational position, and that the projectile is at least substantially continuously provided with information pertaining to the offset roll angle on the basis of which the projectile determines the offset roll angle it is to assume at the moment of fragmentation for its fragments to achieve a reasonable hit probability, if the projectile would be sufficiently close to the target.

31. Method as claimed in claim 30, characterized in that the information pertaining to the offset roll angle is determined on the basis of both a ballistic model of the projectile and measured target positions.

32. Method as claimed in claim 30 or 31, characterized in that a ballistic model of the projectile, measured target positions, and a proximity criterion constitute the basis for determining whether the projectile is in sufficiently close proximity to the target.

33. Method as claimed in claim 30 or 31, characterized in that information from a proximity fuze constitutes the basis for determining whether the projectile has come within sufficiently close range to the target.

34. Method as claimed in any of the claims 30 through 33, characterized in that the external information comprises coded information pertaining to the offset roll angle from which a series of offset roll angles can be determined, which information is, per offset roll angle, valid for one projectile or for a sequence of projectiles flying close together, the information pertaining to the offset roll angle being decoded, per projectile, to obtain an offset roll angle related to the projectile concerned.

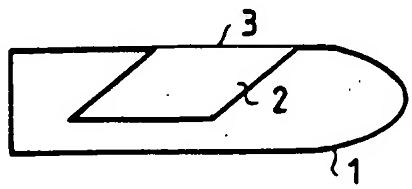

FIG.1A

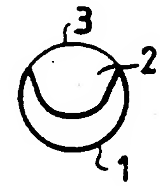

FIG.1B

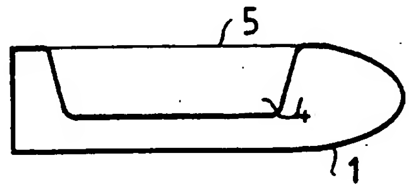

FIG.1C

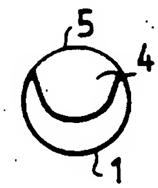

FIG.1D

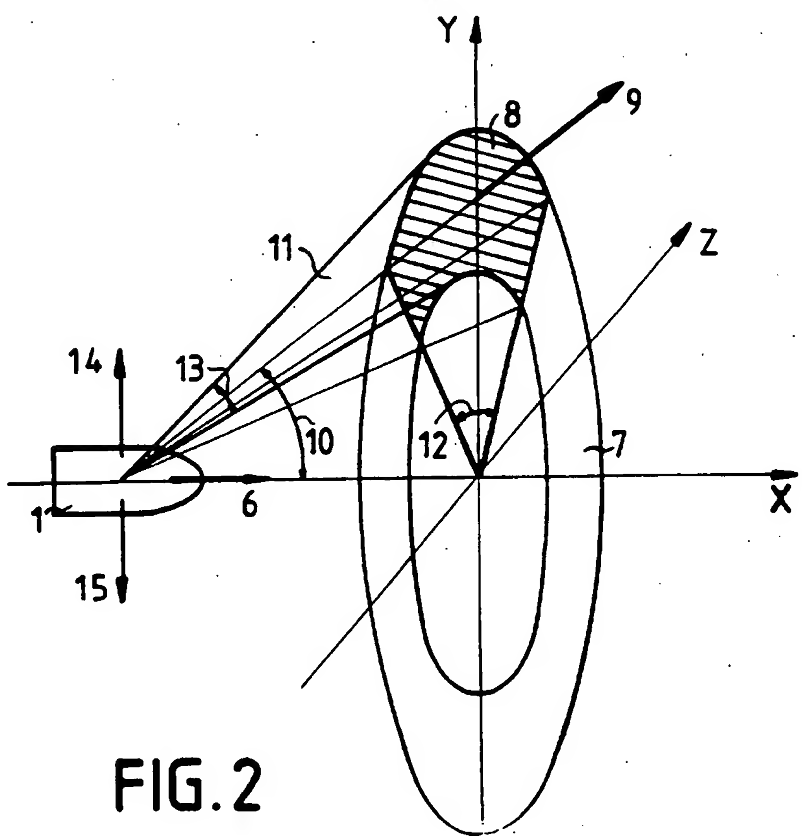

FIG.2

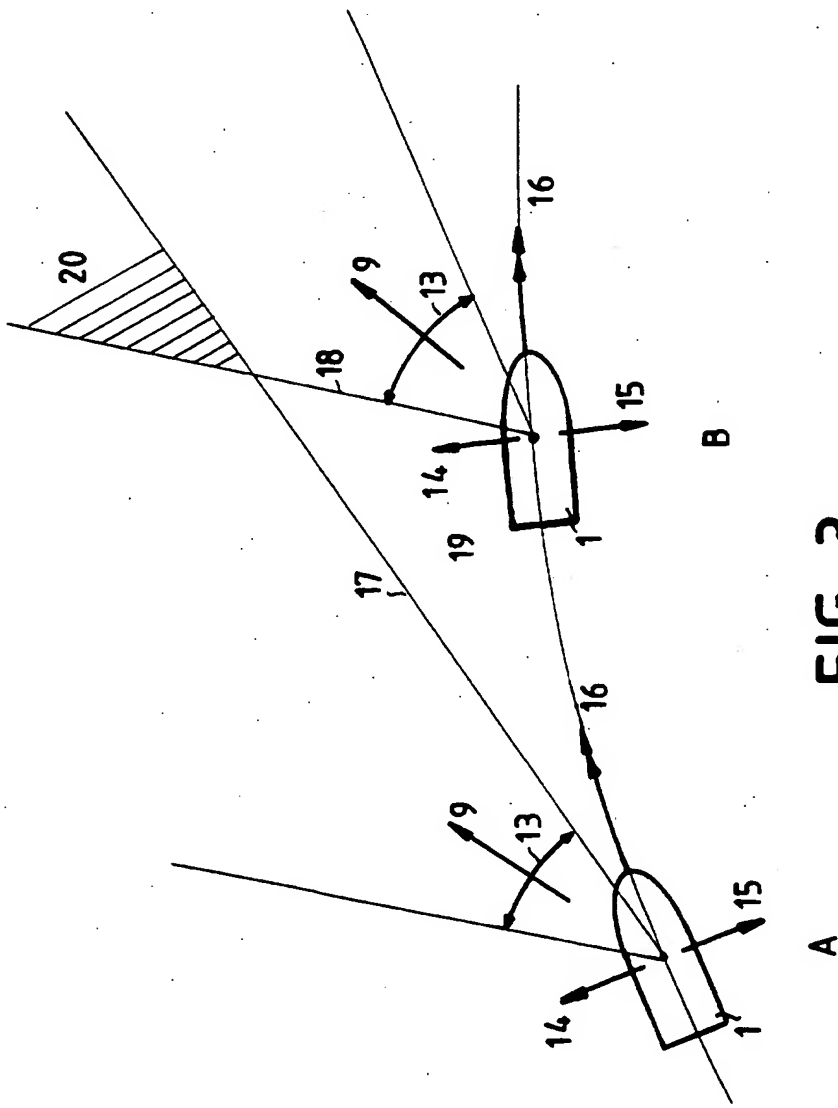

FIG. 3

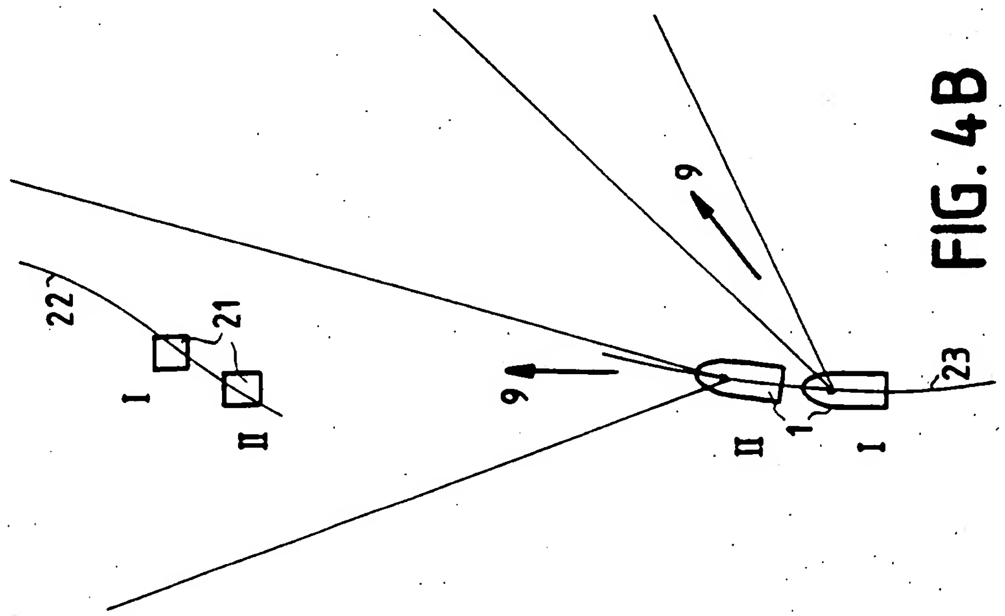

FIG. 4B

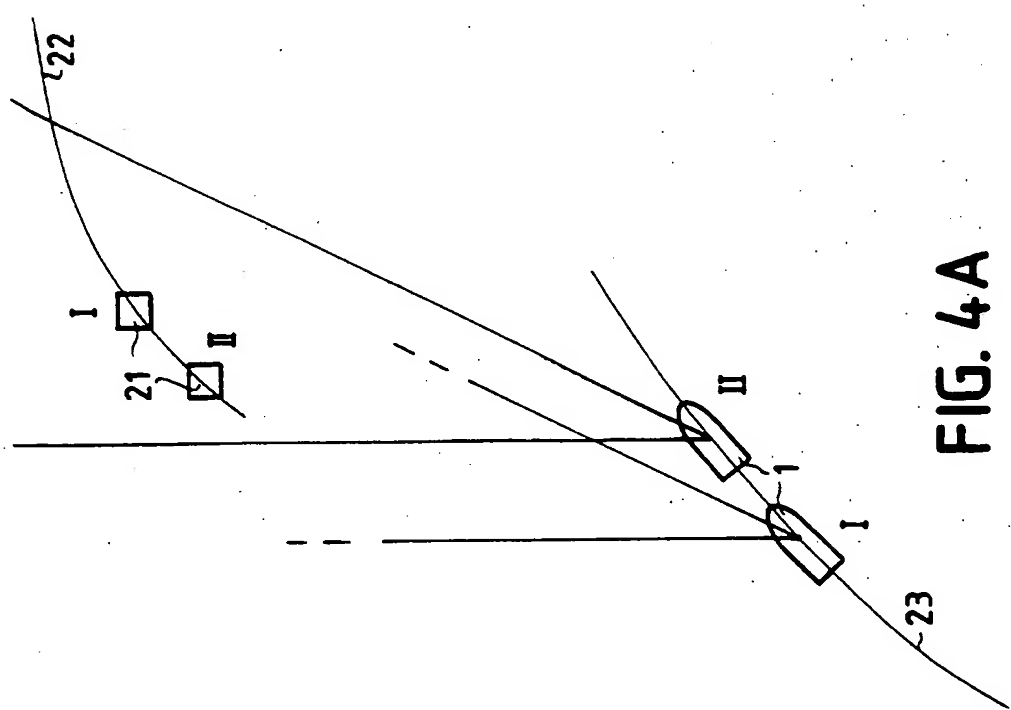

FIG. 4A

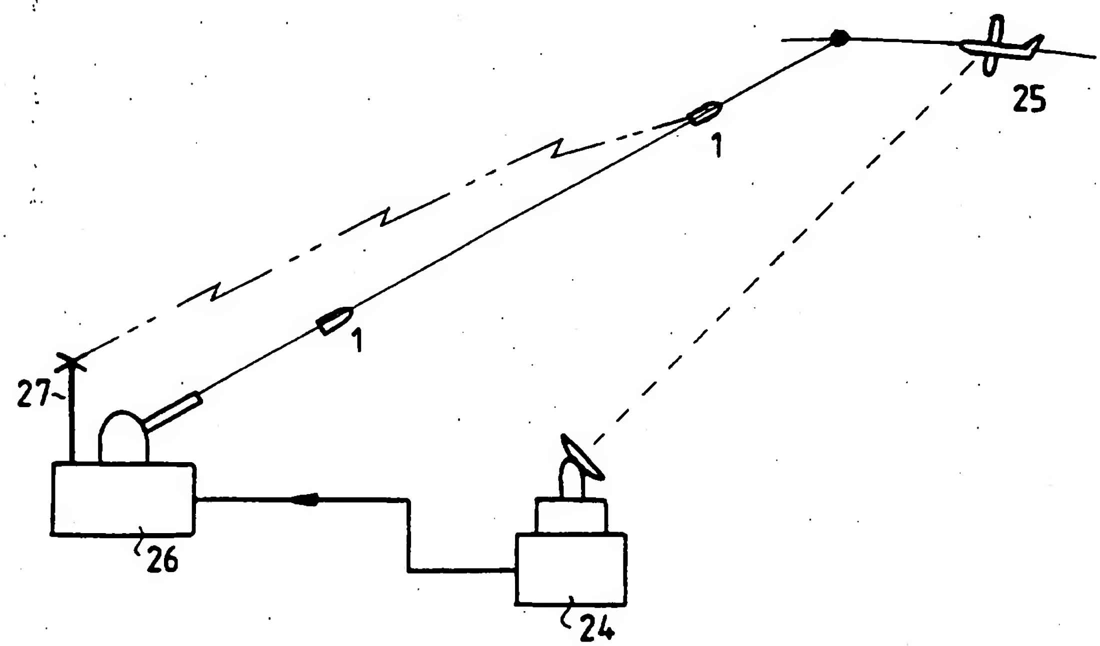

FIG. 5

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 96/04521

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 F42B12/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 F42B F41G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE,A,22 37 140 (LICENTIA PATENTVERWALTUNGS-GMBH) 7 February 1974	1
Y	see the whole document ---	2-34
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Y	US,A,5 003 885 (RUDOLF ET AL.) 2 April 1991 see the whole document ---	2-6,28, 29
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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1

Date of the actual completion of the international search	Date of mailing of the international search report
22 January 1997	10. 02. 97

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Giesen, M

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Information on patent family members

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